ARS-74-16
MAY 1960

RESEARCH FOR BETTER QUALITY IN DRIED FRUITS

Figs

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

THIS REPORT is one of four on dried fruit research conducted during 1958 and 1959 at the Western Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture, Albany 10, Calif. The Dried Fruit Industry Research Advisory Committee has worked closely with this division in support and evaluation of this research program. The assistance of the following groups is gratefully acknowledged:

California Dried Fig Advisory Board
California Raisin Advisory Board
California Prune Advisory Board
Dried Fruit Association of California

Valuable technical assistance was provided by Mr. E. C. Marshall, Mrs. J. G. Harris, and Mr. D. C. Patterson.

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FIGS

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The California fig industry produces about 20,000 tons of dried figs annually (9). The dried figs are used in production of paste, juice, and processed whole figs. Of several varieties, Calimyrna and Mission comprise nearly all the processed whole fig production and of these two the former is the more widely consumed.

It is generally known that deteriorative changes take place in figs, as in other dried fruits, if the fruit is exposed to unfavorable temperature and relative humidity conditions. This paper is a report of the chemical, physical, and organoleptic changes that take place in retail packages of processed Calimyrna figs under a wide range of temperatures and relative humidities. The objectives are to provide specific information about kinds and rates of changes, to indicate improved processing and handling methods that enhance stability, and to devise and test better methods of evaluating quality.

A survey of literature indicates little information on stability of processed retail packages of Calimyrna figs. Barger et al. (3), in their study of low-temperature storage of dried fruits, have discussed some of the changes that take place in bulk-packed figs, and Baker and Mrak (2) have reported on yeasts associated with the "sugaring" of dried prunes and figs. Cruess (5) and Skepper (8) discuss the drying and processing of figs. Condit (4) includes discussions of processing and stability in his treatise on figs.

Materials and Methods

The figs used were obtained from a commercial packing house in San Joaquin County, California. They represent typical retail packages of Calimyrna figs which are distributed in 12-ounce packages. The processing includes washing and heating operations, during which moisture content is adjusted and enzymes are inactivated. An antimycotic agent containing ethylene oxide is added to the packages just before sealing.

Two lots of fruits, each consisting of 216 12-ounce packages of known composition (table 1), were used. One lot was packed in cartons with foil-laminated paper overwrap, the other in transparent saran-treated cellophane (K202) bags. Eighteen packages from each lot were

Table 1. --Analyses of Calimyrna figs used in the study

Determinations	Bags(K202)	Cartons
Moisture (by vacuum oven method), pct.	27.6	27.0
Moisture (Dried Fruit Assoc. moisture Meter), pct.	26.0	25.5
Sugar content, pct. Total	53.0	52.4
Reducing	50.9	50.6
Fructose	26.3	25.8
Glucose	24.6	24.8
Sucrose	2.1	1.8
Crude fiber, pct.	3.28	3.83
Nitrogen, pct.	.42	.60
Ash, pct.	2.06	1.89
Acidity (ml. of 0.1N NaOH to bring 100-gram sample to pH 8)	86.7	78.4

Figure 1. --Constant temperature, constant relative humidity chambers used for dried fruit stability tests.

placed in each of 12 chambers (fig. 1) maintained at constant temperatures (35°, 50°, 70°, 90° F.) and relative humidities (40, 60, and 80 percent). Three packages were withdrawn at each sampling time. The analyses are reported in detail below.

Alcohol Extractable Color

A 15-gram sample of well mixed ground dried fruit was placed in a 300-ml. Erlenmeyer flask containing 200 ml. of 50 percent ethanol. The flask was then covered with Parafilm and allowed to remain at room temperature for 23 hours with occasional shaking[1]. The colored solution was then filtered through Whatman No. 2 filter paper and the color reading made with a Bausch and Lomb spectrophotometer (Spectronic 20) at 440 mμ using a 1.2-cm. cell. The results are recorded as absorbance ($A = \log_{10} \frac{1}{T}$), with a 50 percent ethanol solution used for zero adjustment. These results are converted to a moisture-free basis by dividing the observed absorbance value by the fraction of the original sample that was total solids.

Moisture Determination

Moisture determinations were made by the vacuum-oven method. The procedure employed, with some modification, was that of the Association of Official Agricultural Chemists (1) and Makower, Chastain, and Nielsen (7). A number of analyses were also made with the dried fruit moisture tester[2] in order to compare the two methods. This moisture tester (DFA meter) was used in the prescribed fashion with no further adjustment. The conversion tables provided with the instrument were used for calculating moisture content. In the vacuum-oven determinations a 4-gram sample of well blended, ground dried fruit weighed accurately to 1 mg. was placed in a moisture dish containing 5 grams of washed and ignited coarse sand and a short stirring rod. The contents of the moisture dish were stirred and well mixed. (The rod is not removed during the course of moisture determination.) The dish was placed on a steam bath for 15 minutes and then held in a vacuum oven for 30 hours at 60° C. at less than 2 mm. Hg. pressure. Moisture is expressed as percentage of original sample weight.

Sugars

The method of Munson-Walker (1) was employed for total and reducing sugars and that of Williams and Potter (10) for fructose determinations. Sucrose and glucose were determined by difference. Sugar contents are expressed in percentage of original sample weight.

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[1]Use of trade names of specific materials or equipment does not constitute a recommendation by the U.S. Department of Agriculture.

[2]Dried Fruit Association of California.

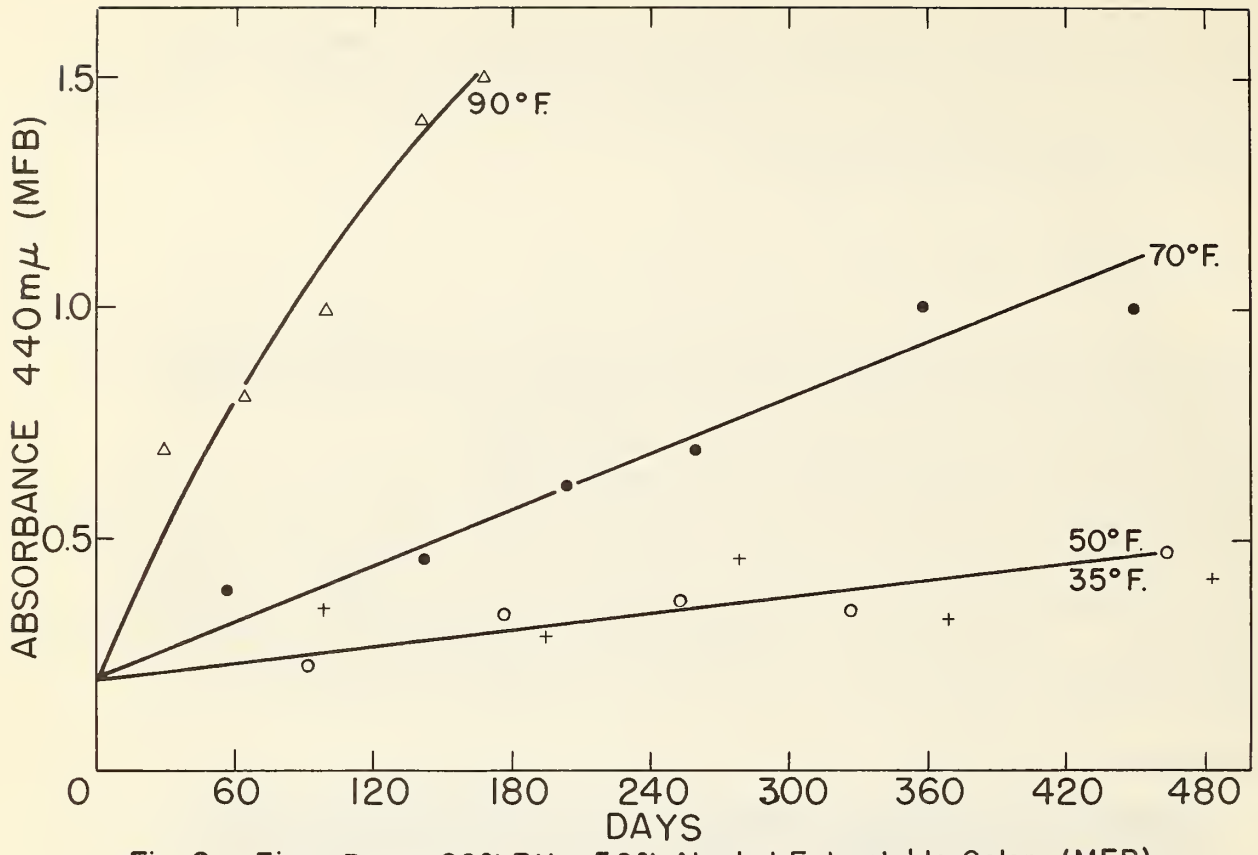

Fig. 2 Figs, Bags, 60% RH. 50% Alcohol Extractable Color (MFB)

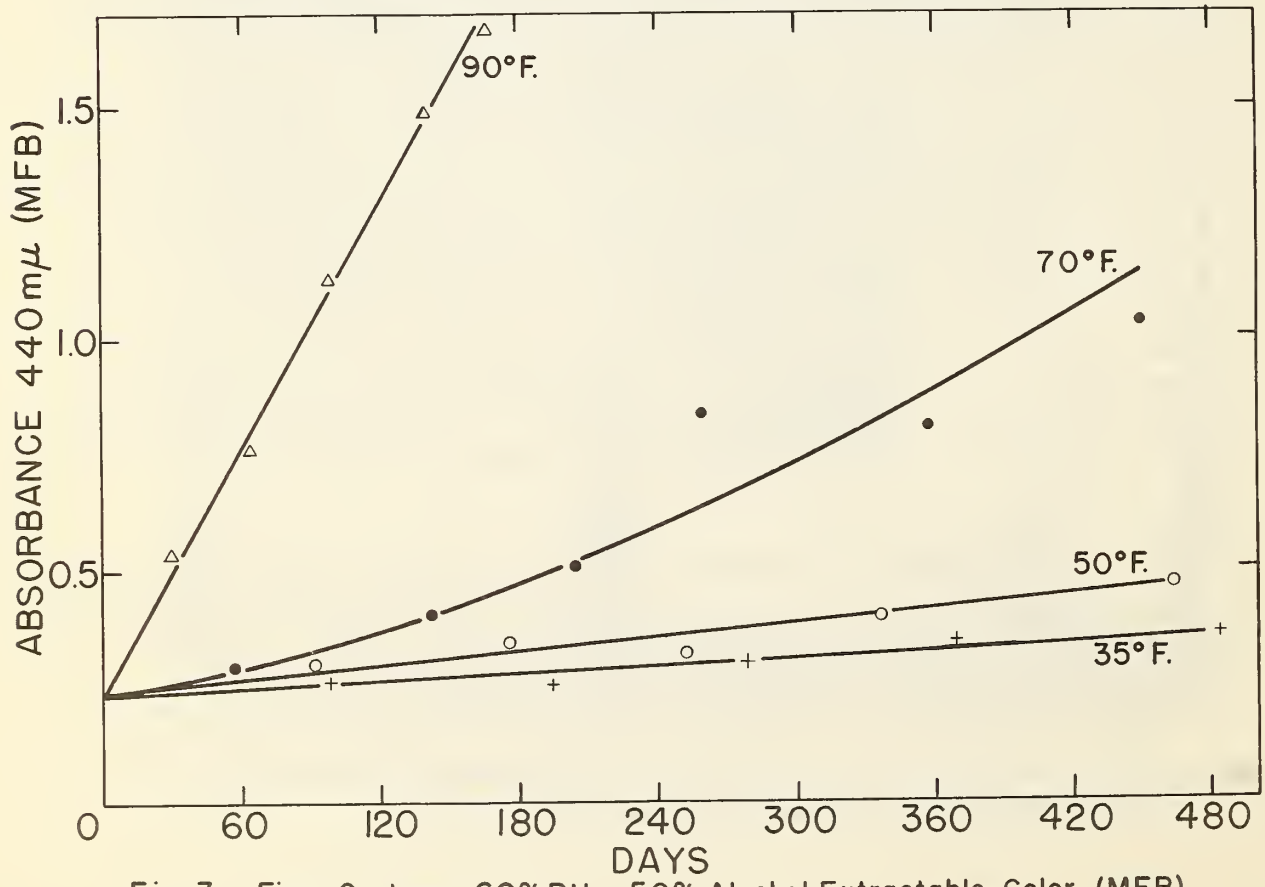

Fig. 3 Figs, Cartons, 60% RH. 50% Alcohol Extractable Color (MFB)

Visual and Tactile Changes

Samples withdrawn for various analyses were examined for changes in texture, sugaring, and growth of micro-organisms.

Weight Changes in Retail Packages

Four packages in K202 bags and four in cartons with foil-laminated-to-paper overwrap were weighed periodically throughout the experiments to the nearest 0.5 gram. The weight changes in these unopened packages are expressed as percentages of the original weight.

Flavor

Representative samples of dried fruits were withdrawn from the storage chambers at various intervals, hermetically sealed in No. 2 cans, and stored at -30° F. for subsequent determination of flavor changes by a laboratory taste panel. A control group was kept at -30° F. for the comparisons made by triangle taste tests (6).

Results and Discussion

Color Changes

Because the natural color of Calimyrna figs is light, darkening is a major deteriorative change and a knowledge of color changes that occur under a wide variety of atmospheric conditions is essential. This information is also useful in production quality control. Figures 2 and 3 represent the results of color analyses of Calimyrna figs for 60 percent relative humidity at 35°, 50°, 70° and 90° F. The results of the color analyses (expressed on moisture-free basis) for 40 and 80 percent relative humidity storage at various temperatures showed no significant difference from that of 60 percent and corresponding temperatures. For this reason, the data for only 60 percent relative humidity are presented here. An extracted color absorbance value of about 0.75 (moisture-free basis) usually indicated that the figs had darkened to the point where their acceptability was considered doubtful by the authors. After 2 months at 90° F., darkening was nearly equal to that of figs stored at 70° F. for 10 to 11 months. At 35° and 50° F. the figs had very nearly their original color after 15 months of storage.

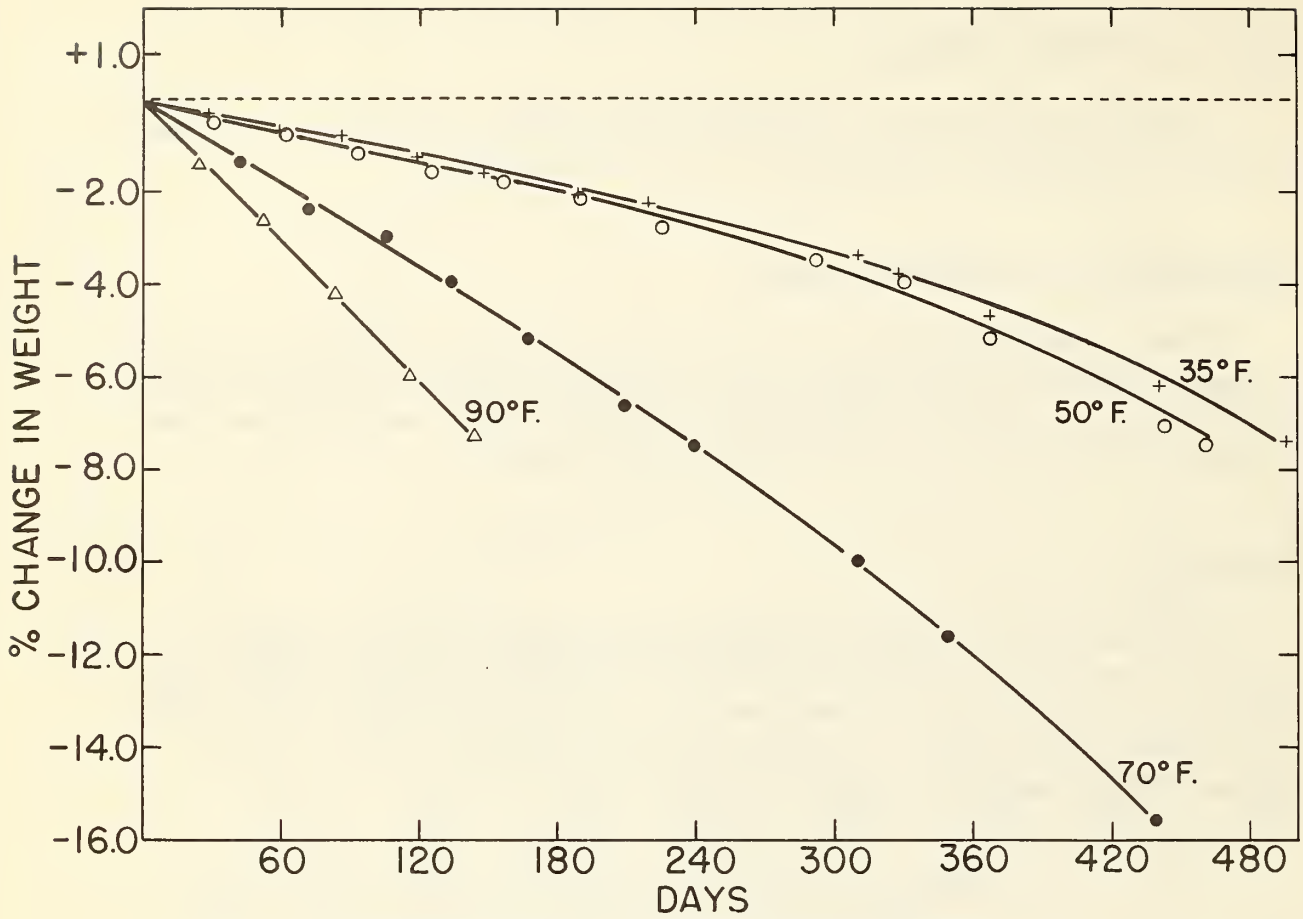

Fig. 4 Figs, Bags, 40% RH. Percent Change in Weight

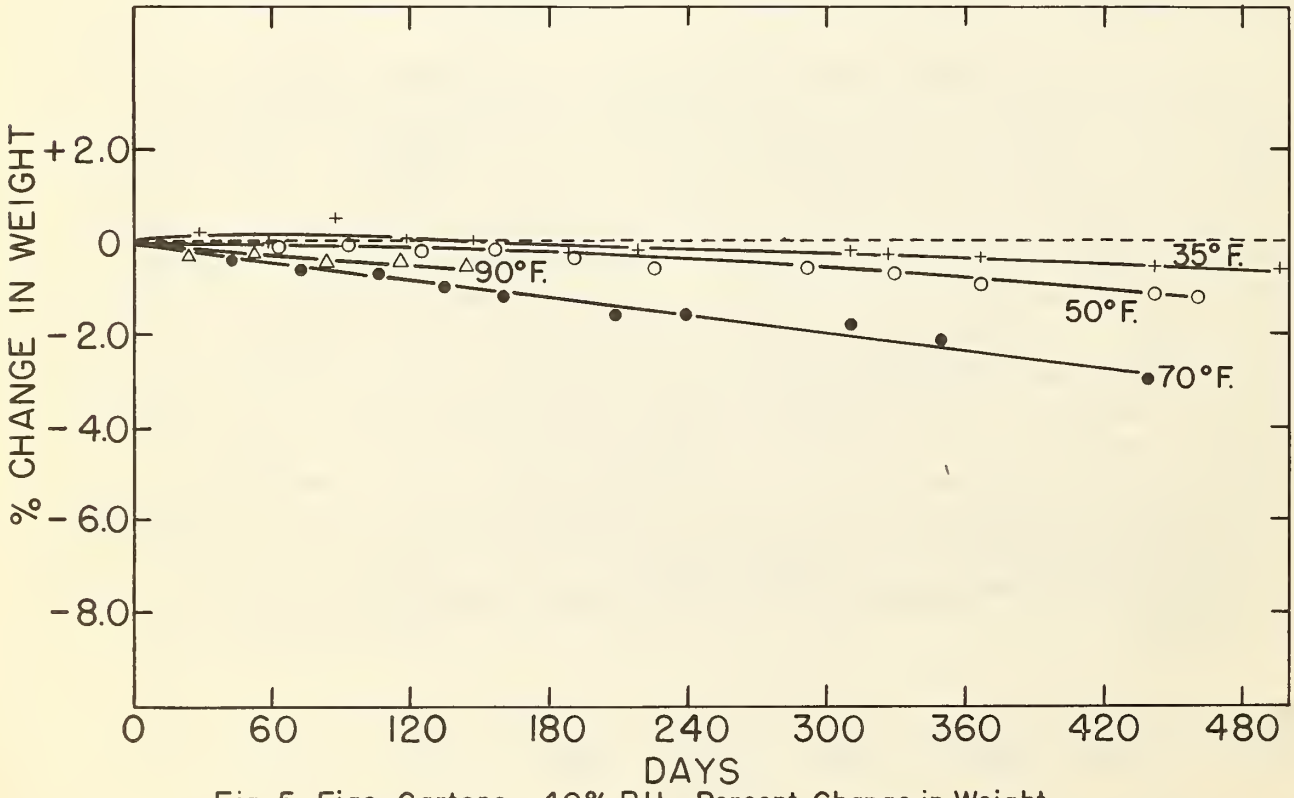

Fig. 5 Figs, Cartons, 40% RH. Percent Change in Weight

Moisture and Weight Changes

Figures 4 to 9 show gross weight changes in retail packages of Calimyrna figs. Nearly constant weight was maintained at 80 percent relative humidity in carton-packed and in bagged fruit, with the exception of fruits stored at 35° F. in cartons. The carton-packed fruits under all conditions were more resistant to weight changes than bagged fruits. Weight losses of nearly 15 percent were noted in the latter when stored at 70° F. and 40 percent relative humidity for about 15 months. At 40 percent relative humidity the bagged fruits had lost significant amounts of weight even at 50° and 35° F. after 10 months. No important differences were noted in the gross weight changes between fruits stored at 35° F. and 50° F. in most cases. Vacuum-oven moisture analyses showed a large degree of variation in the results--attributed largely to variation in the fruit. Figure 10 shows the results of moisture determination by the vacuum-oven method for figs stored at 40 percent relative humidity at 35°, 50°, 70°, and 90° F. The moisture analyses for fruits stored at other relative humidities in general show trends similar to the gross weight changes. A comparison of moisture analyses by vacuum oven and Dried Fruit Association moisture meter showed that the latter gave slightly lower moisture values.

Flavor Changes

Flavor evaluation of bagged Calimyrna figs stored at 50°, 70°, and 90° F., all at 60 percent relative humidity, were made by means of triangle taste tests (6) with a panel of 10 judges, each of whom tasted two sets of samples. Control samples were held at -30° F. Differences from the control were noted when figs were stored at 90° F. for 12 weeks. After 42 weeks at 70° F. and 54 weeks at 50° F., the panel was unable to distinguish the test sample from the control to a significant degree; these periods indicate good flavor retention at both temperatures.

Sugar Content Changes

Figure 11 shows the results of sugar analyses for the Calimyrna figs stored at 90° F. and 60 percent relative humidity. No significant changes in total or component sugars were noted under any of the various atmospheric conditions of the experiment.

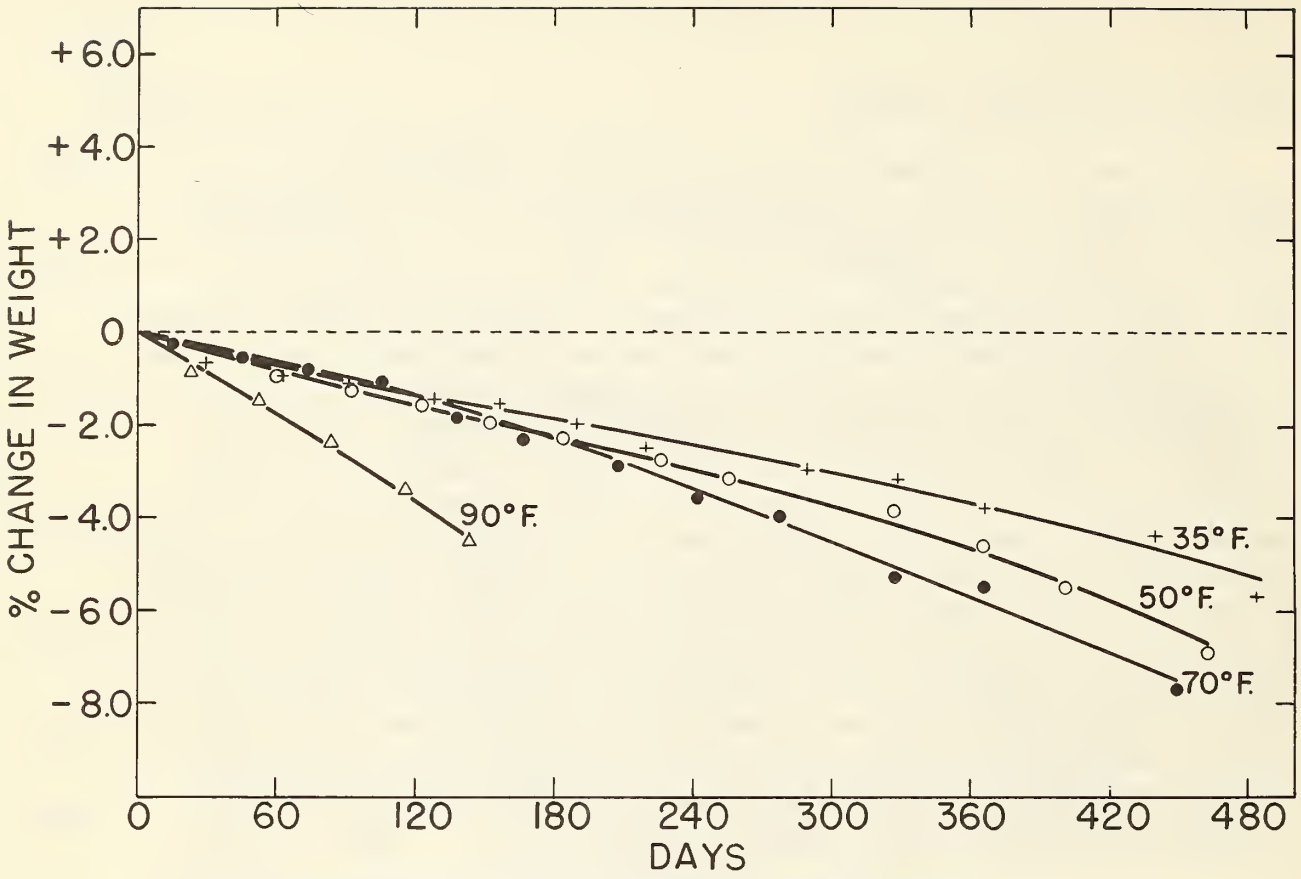

Fig. 6 Figs, Bags, 60% RH. Percent Change in Weight

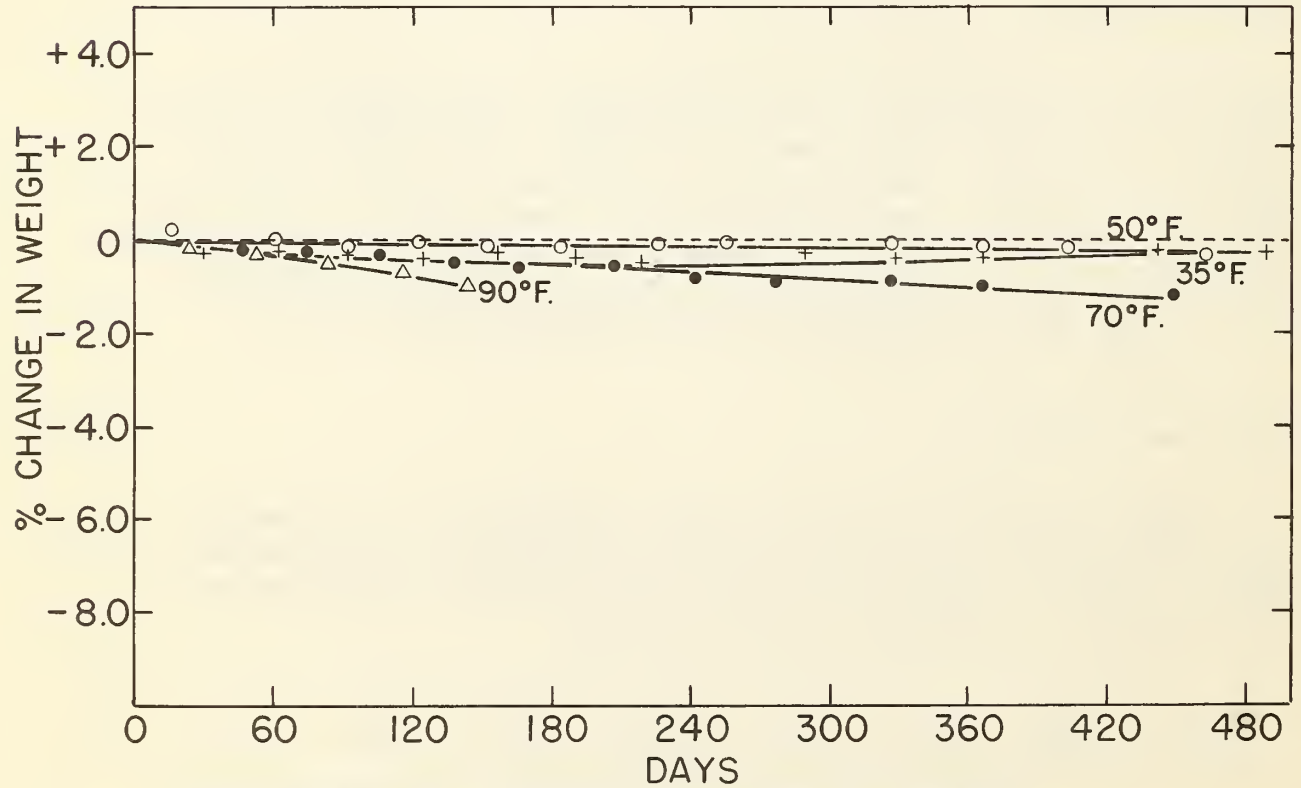

Fig. 7 Figs, Cartons, 60% RH. Percent Change in Weight

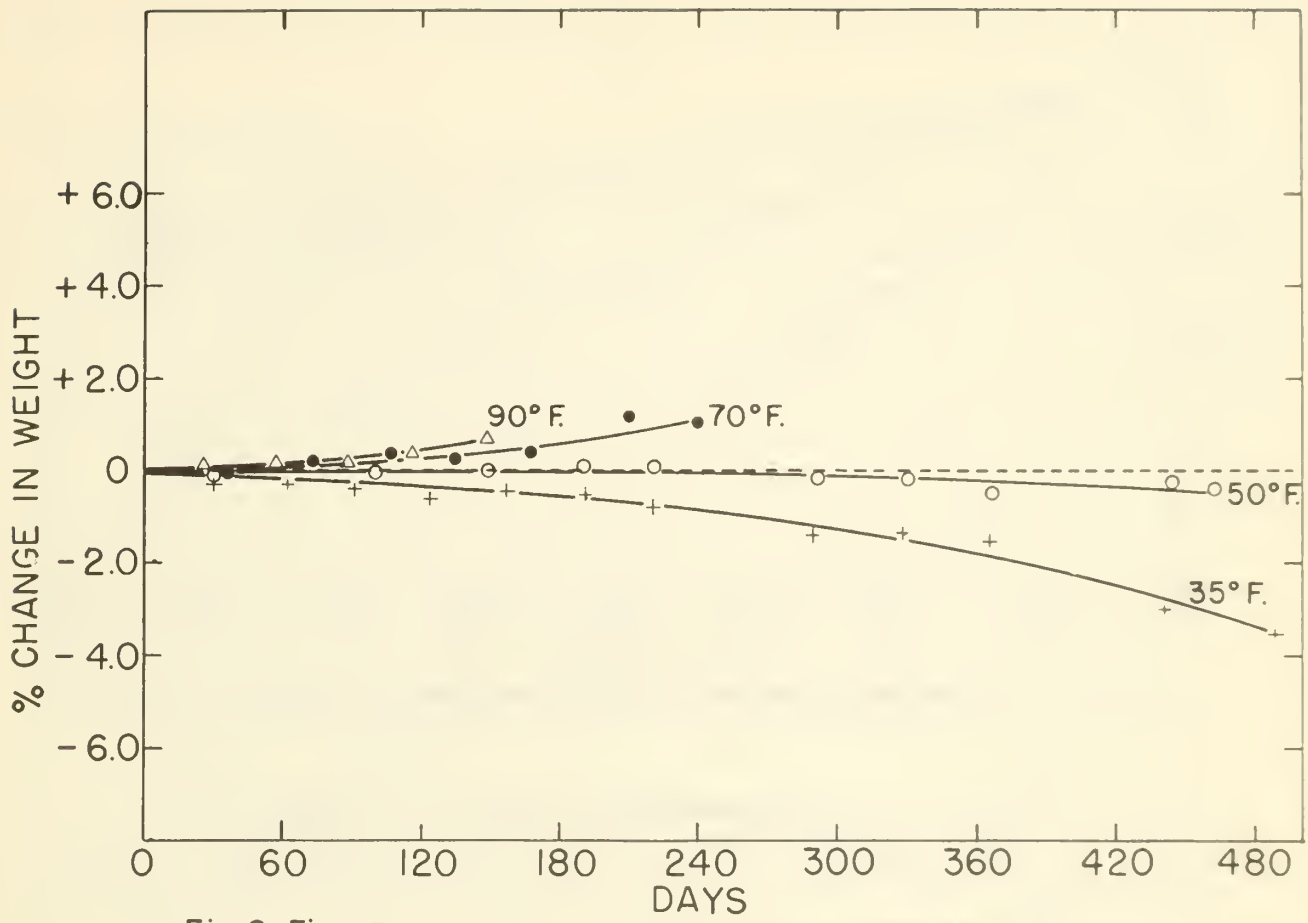

Fig. 8 Figs, Bags, 80% RH. Percent Change in Weight

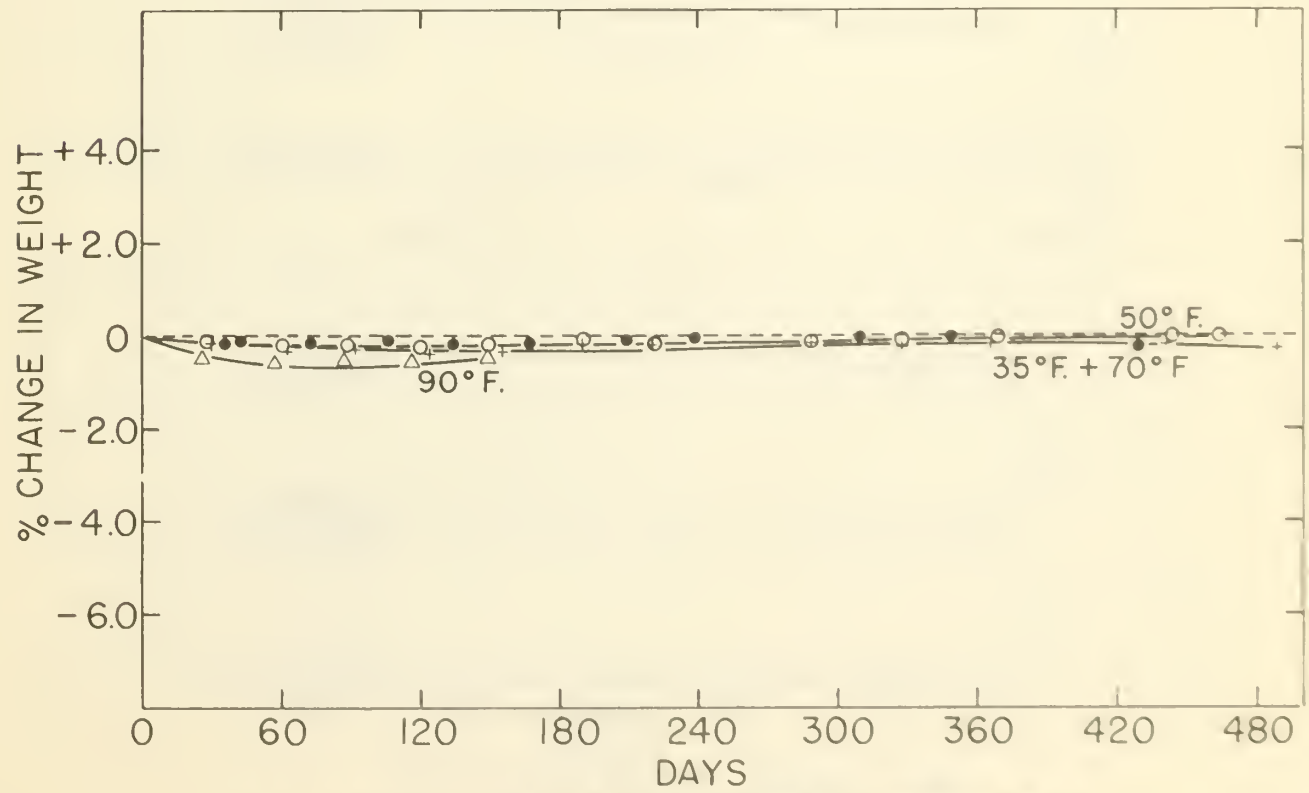

Fig 9 Figs, Cartons, 80% RH. Percent Change in Weight

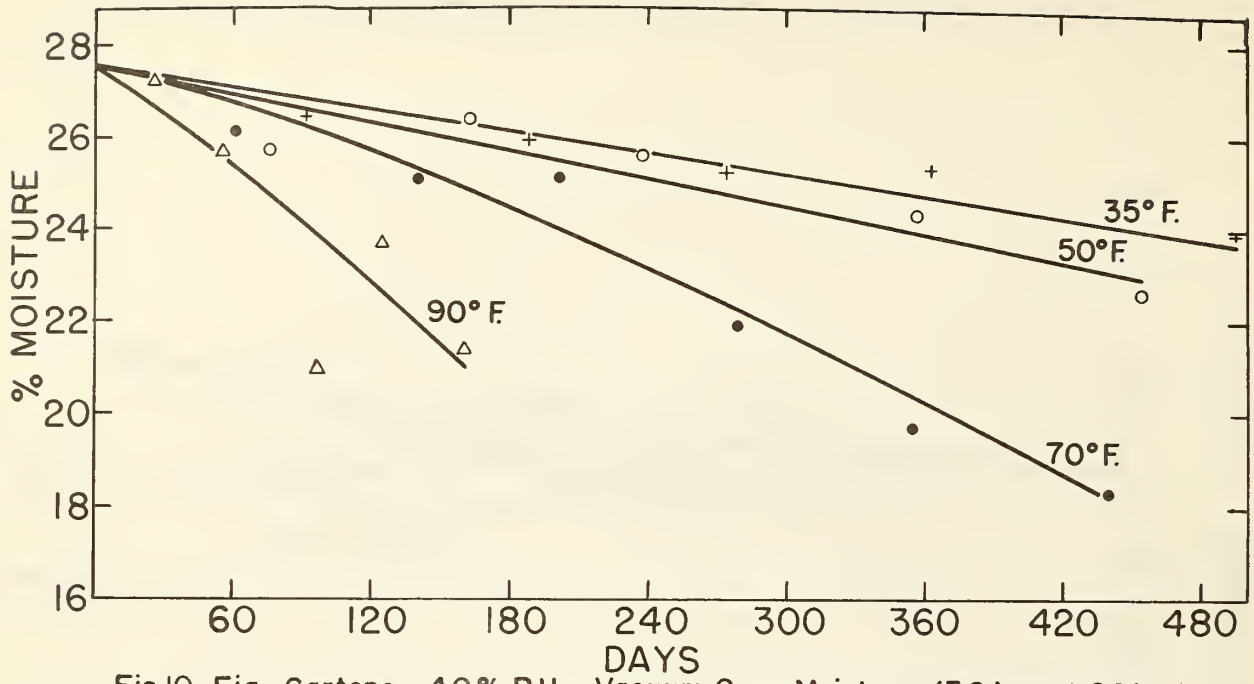

Fig.10 Fig, Cartons, 40% RH. Vacuum Oven Moisture (30 hrs. at 60° C.)

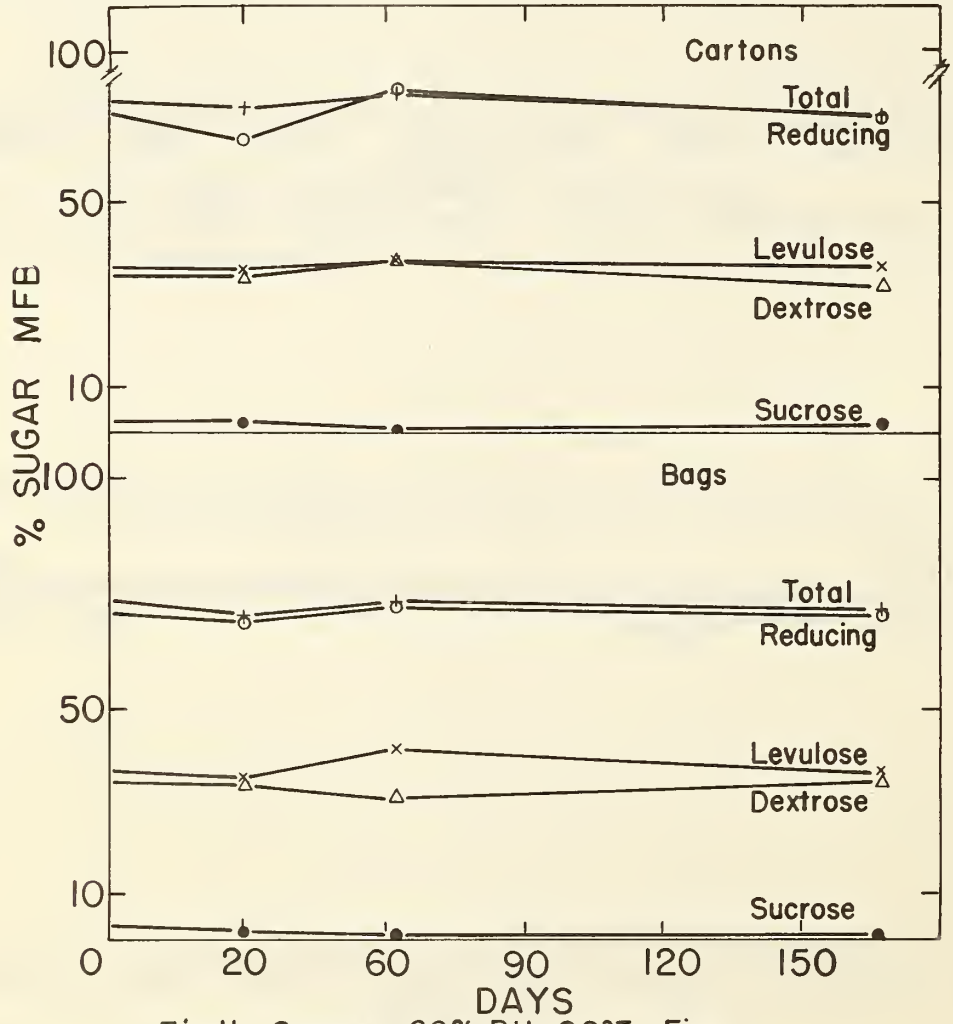

Fig.11 Sugars, 60% RH, 90°F., Figs

Visual Appearance

The figs underwent distinct visual changes in this study. At 90° F., aside from rapid discoloration, sweating occurred in both bags and cartons at 80 and 60 percent relative humidity. At 40 percent, the figs in bags, and to a lesser degree in cartons, became very dry and hard and were shriveled in appearance. Several of the bags at 70° F. and 80 percent relative humidity developed mold colonies and by the fifth month were fully covered by a mass of white mold. In a few bags "sugaring" also occurred at this temperature and humidity by the sixth month. At 70° F. and 40 percent relative humidity the bagged figs became very hard after 10 to 12 months. At 50° and 35° F.. and all relative humidities nearly all the bags showed evidence of "sugaring" after 5 months. The amount of surface and subsurface granulation increased during storage, proceeding apparently at a more rapid rate at the higher humidities. The fruit in cartons also "sugared", although after longer periods of storage at 50° and 35° F. and to a far lesser degree.

It should be noted that the figs in this study had nearly 26.0 percent moisture; higher-moisture figs might remain free of "sugaring". No evidence of insect growth was noted in any of the packages of figs during the entire study.

Summary

The results of a stability study of retail packages of Calimyrna figs under a wide variety of atmospheric conditions are reported.

Color changes were independent of relative humidity of the atmosphere and packaging container. The degree of discoloration at 90° F. after 2 months of storage was equal to that of the figs stored at 70° F. for nearly 10 months. No appreciable discoloration occurred at 50° F. or 35° F. However, at these lower temperatures, bagged figs "sugared" rapidly on the surface, and the degree of "sugaring" increased as storage continued. The carton-packed figs also "sugared" at these temperatures, but to a much lesser degree. "Sugaring" appeared to be the major disadvantage for cold storage of packaged dried figs. Otherwise, cold storage helped retain the color and flavor, as well as the original weight of the figs. In all cases, little or no difference in quality was noted between the fruits stored at 35° F. and those stored at 50° F. Therefore, it appears that if "sugaring" can be avoided, perhaps by processing higher-moisture figs, 50° F. offers nearly optimum conditions for general over-all quality

retention at least up to 16 months of storage. In nearly all cases, the cartons maintained a better quality fig than the bags. For the figs (carton-packed) used in this study, 70° F. storage at 80 or 60 percent relative humidity appeared to be adequate for up to 8 months.

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GPO 980100